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I. AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

1 1. (Currently amended) A triple-junction solar cell comprising:
2 a first cell layer comprising a germanium (Ge) substrate having a first and second
3 diffusion regions doped with n-type dopants, wherein the second diffusion
4 region diffuses deeper into the Ge substrate than the first diffusion region,
5 wherein ~~the n-type dopants in the first diffusion region~~ has a higher
6 concentration of ~~includes~~ phosphorus (P) atoms than arsenic (As) atoms and
7 ~~having the highest dopant concentration and the n-type dopants in the second~~
8 diffusion region has a higher ~~includes arsenic (As) atoms having the highest~~
9 dopant concentration of As atoms than P atoms;
10 a nucleation layer disposed over the Ge substrate of the first cell layer;
11 a second cell layer comprising one of gallium arsenide (GaAs) and indium gallium
12 arsenide (InGaAs) disposed over the nucleation layer; and
13 a third cell layer comprising indium gallium phosphide (InGaP) disposed over the
14 second cell layer.

1 2. (Original) The triple-junction solar cell as recited in Claim 1 wherein the nucleation
2 layer comprises a material having a lattice parameter substantially equal to the
3 lattice parameter of the germanium substrate.

1 3. (Original) The triple-junction solar cell as recited in Claim 1 wherein the nucleation
2 layer comprises InGaP.

1 4. (Original) The triple-junction solar cell as recited in Claim 1 wherein the nucleation
2 layer has a thickness substantially equal to 350 Å or less.

1 5. (Previously presented) The triple-junction solar cell as recited in Claim 1, wherein
2 the triple-junction solar cell is capable of absorbing radiation ranging from
3 approximately ultraviolet (UV) radiation to radiation having a wavelength of
4 approximately 1800 nm.

1 Claims 6-7. (Cancelled).

1 8. (Original) The triple-junction solar cell as recited in Claim 1 wherein the junction
2 depth in the first cell layer is substantially between 0.3 µm and 0.7 µm.

1 9. (Original) The triple-junction solar cell as recited in Claim 1 wherein the first cell
2 layer comprises a two-step diffusion profile capable of optimizing current and
3 voltage generated therefrom.

1 10. (Original) The triple-junction solar cell as recited in Claim 1 having 1 sun AM0
2 efficiencies in excess of 26%.

1 11. (Currently amended) A triple-junction solar cell comprising:
2 a dual-junction structure comprising a first junction and a second junction;
3 a third junction having a p-type substrate, wherein the third junction is doped with
4 arsenic (As) and phosphorus (P), wherein the p-type substrate includes [[a]] first
5 and second diffusion sublayers, wherein at least a portion of the second
6 diffusion sublayer is deeper into the p-type substrate than the first diffusion
7 sublayer, wherein [[the]] P atoms have higher concentration compared to As
8 atoms in the first diffusion sublayer and [[the]] As atoms have a higher
9 concentration compared to P atoms in the second diffusion sublayer; and
10 a nucleation layer disposed between the dual-junction structure and the third junction
11 and comprising a material that shares a substantially similar lattice parameter
12 with the p-type substrate of the third junction, wherein the nucleation layer
13 serves to control the diffusion depth of the third junction.

1 12. (Previously presented) The triple-junction solar cell as recited in Claim 11 wherein
2 the p-type substrate of the third junction is germanium (Ge) and the nucleation
3 layer comprises indium gallium phosphide (InGaP).

1 13. (Original) The triple-junction solar cell as recited in Claim 11 wherein the
2 nucleation layer has a thickness substantially equal to 350 Å or less.

1 Claims 14-15. (Cancelled).

1 16. (Original) The triple-junction solar cell as recited in Claim 11 wherein the junction
2 depth of the third junction is substantially between 0.3 μm and 0.7 μm .

1 17. (Original) The triple-junction solar cell as recited in Claim 11 wherein the third
2 junction comprises a two-step diffusion profile capable of optimizing current
3 and voltage generated from the third junction.

1 18. (Original) The triple-junction solar cell as recited in Claim 11 having 1 sun AM0
2 efficiencies in excess of 26%.

1 19. (Original) The triple-junction solar cell as recited in Claim 11 capable of absorbing
2 radiation ranging from approximately ultraviolet (UV) radiation to radiation
3 having a wavelength of approximately 1800 nm.

1 20. (Currently amended) A method for controlling the diffusion of a dopant into a
2 substrate during a subsequent device process during the fabrication of a multi-
3 layer semiconductor structure, the method comprising:

- 4 (a) disposing a nucleation layer over the substrate;
- 5 (b) performing the subsequent device process to form an overlying device layer
6 containing the dopant, wherein the dopant[[s]] includes phosphorus (P) and
7 arsenic (As), wherein the nucleation layer serves as a diffusion barrier to the
8 dopant in the overlying device layer such that diffusion of the dopant into the
9 substrate is limited by increasing the thickness of the nucleation layer, wherein

10 the performing the subsequent device process further includes diffusing P atoms
11 to a shallow diffusion region and diffusing As atoms to a deep diffusion region
12 of the substrate.

1 21. (Original) The method as recited in Claim 20 wherein the nucleation layer
2 comprises a material that shares an identical lattice parameter with the substrate.

1 22. (Original) The method as recited in Claim 20 wherein the substrate is germanium
2 (Ge) and the nucleation layer comprises InGaP.

1 23. (Original) The method as recited in Claim 20 wherein the nucleation layer has a
2 thickness substantially equal to 350 Å or less.

1 Claims 24-25. (Cancelled).

1 26. (Previously presented) The method as recited in Claim 20 wherein a two-step
2 diffusion profile is achieved in an n-p junction formed in the substrate.

1 27. (Original) The method as recited in Claim 20 wherein the subsequent device
2 process includes metal organic chemical vapor deposition (MOCVD).

1 28. (Original) The method as recited in Claim 20 wherein the nucleation layer also
2 serves as a source of the dopant for forming an n-p junction in the substrate.

1 29. (Original) The method as recited in Claim 20 wherein diffusion of the dopant into
2 the substrate primarily involves solid state diffusion.

1 30. (Original) The method as recited in Claim 29 wherein diffusion of the dopant into
2 the substrate also involves gas phase diffusion during oxide desorption.

1 31. (Currently amended) A method for fabricating a multi-layer semiconductor
2 structure, the method comprising:

3 (a) preparing a germanium (Ge) substrate layer for doping by a dopant, wherein the
4 dopant[[s]] includes phosphorus (P) atoms and arsenic (As) atoms;

5 (b) disposing a nucleation layer over the germanium substrate layer;

6 (c) disposing a middle layer comprising the As atoms over the nucleation layer,
7 wherein the disposing a nucleation layer further includes controlling diffusion of
8 the P atoms into a first diffusion sublayer and diffusion of the As atoms into a
9 second diffusion sublayer, wherein the first diffusion sublayer is substantially
10 adjacent to the nucleation layer and the second diffusion sublayer is adjacent to
11 the first diffusion sublayer; and

12 (d) disposing a top layer comprising indium gallium phosphide (InGaP) over the
13 second tunnel junction, wherein the nucleation layer serves as a diffusion barrier
14 such that diffusion of the dopant into the germanium substrate can be limited by
15 increasing the thickness of the nucleation layer.

1 32. (Original) The method as recited in Claim 31 wherein the nucleation layer
2 comprises a material having a lattice parameter substantially equal to the lattice
3 parameter of the germanium substrate.

1 33. (Original) The method as recited in Claim 31 wherein the nucleation layer
2 comprises InGaP.

1 34. (Original) The method as recited in Claim 31 wherein the nucleation layer has a
2 thickness substantially equal to 350 Å or less upon completion of said step (b).

1 Claims 35-36. (Cancelled).

1 37. (Previously presented) The method as recited in Claim 31 wherein a junction
2 depth in the germanium substrate layer is substantially between 0.3 μm and 0.7
3 μm upon completion of said steps (a) through (d).

1 38. (Currently amended) A multi-junction solar cell comprising:
2 a p-type germanium (Ge) substrate having a first surface, wherein the p-type Ge
3 substrate further includes ~~a diffusion portion having~~ a first diffusion sublayer
4 situated adjacent to the first surface of the p-type Ge substrate and a second
5 diffusion sublayer situated adjacent to the first diffusion sublayer;
6 an indium gallium arsenide (InGaAs) nucleation layer disposed over the first surface of

7 the p-type Ge substrate, wherein the InGaAs nucleation layer provides n-type
8 phosphorus (P) atoms to the first diffusion sublayer, wherein the first diffusion
9 sublayer has a higher concentration of P atoms than arsenic (As) atoms; and
10 a Gallium Arsenide (GaAs) buffer layer including arsenic (As) atoms disposed over the
11 InGaAs nucleation layer, wherein the GaAs buffer layer provides n-type As
12 atoms to the second diffusion sublayer in response to the thickness of the
13 InGaAs nucleation layer.

1 39. (Original) The multi-junction solar cell of claim 38, further comprising a
2 second surface situated at the bottom of the multi-junction solar cell.

1 40. – 42. (Canceled).

1 43. (Currently amended) The multi-junction solar cell of claim 38[[42]], wherein
2 ~~the As atoms in the~~ second diffusion sublayer has a higher ~~the highest dopant~~
3 concentration of As atoms than P atoms.

1 44. (Currently amended) A multi-junction solar cell comprising:
2 a p-type germanium (Ge) substrate having a first surface, wherein the p-type Ge
3 substrate further includes a diffusion portion having a first diffusion region
4 situated adjacent to the first surface of the p-type Ge substrate and a second
5 diffusion region, which includes a part of all of the first diffusion region,
6 wherein the second diffusion region diffuses deeper into the Ge substrate than

7 the first diffusion region;
8 a phosphorus (P) containing nucleation layer disposed over the first surface of the p-
9 type Ge substrate, wherein the P containing nucleation layer provides n-type
10 ~~phosphorus (P)~~ P atoms to the first diffusion region; and
11 an arsenic (As) containing buffer layer ~~including arsenic (As) atoms~~ disposed over the P
12 containing nucleation layer, wherein the As containing buffer layer [[of GaAs]]
13 provides n-type As atoms to the second diffusion region in response to the
14 thickness of the P containing nucleation layer, wherein the second diffusion
15 region has a higher concentration of As atoms than P atoms.

1 45. (Original) The multi-junction solar cell of claim 44, further comprising a
2 second surface situated at the bottom of the multi-junction solar cell.

1 46. (Currently amended) The multi-junction solar cell of claim 44, wherein the first
2 diffusion region ~~includes the P atoms and As atoms; wherein the P atoms in the~~
3 ~~first diffusion region~~ has a higher ~~the highest dopant concentration of P atoms~~
4 than As atoms.

1 47. – 48. (Canceled).

1 49. (Currently amended) A multi-junction solar cell comprising:
2 a germanium (Ge) substrate having ~~a first surface, wherein the substrate further includes~~
3 ~~a diffusion portion having~~ a first diffusion region ~~situated adjacent to the first~~

4 ~~surface of the substrate and a second diffusion region, which includes a part of~~
5 ~~all of the first diffusion region,~~ wherein the second diffusion region diffuses
6 deeper into the Ge substrate than the first diffusion region;
7 a phosphide nucleation layer disposed over the first surface of the substrate, wherein the
8 phosphide nucleation layer provides diffusion dopants of phosphorus (P) atoms
9 to the first diffusion region; and
10 an arsenide layer ~~having arsenic (As) atoms~~ disposed over the phosphide nucleation
11 layer, wherein the arsenide layer provides diffusion dopants of arsenic (As)
12 [[As]] atoms into the second diffusion region in response to the thickness of the
13 phosphide nucleation layer, wherein the first diffusion region has a higher
14 concentration of P atoms than As atoms.

1 50. (Original) The multi-junction solar cell of claim 49, further comprising a
2 second surface situated at the bottom of the multi-junction solar cell.

1 51. (Canceled).

1 52. (Currently amended) The multi-junction solar cell of claim 49, wherein the
2 second diffusion region ~~includes the P atoms and As atoms,~~ wherein the As
3 ~~atoms in the second diffusion region~~ has a higher ~~the highest~~ dopant
4 concentration of As atoms than P atoms.

1 53. (Canceled).